The Use of a

# *Mathematical Instrument,*

called a

# QUADRANT.

Shewing very plainly and easily to know the exact Height or Distance of any Steeple, Tree or House, &c. Also to know the Hour of the Day by it: the Height of the *Sun*, *Moon*, or *Stars*: and to know the time of Sun rising, and setting; and the length of every Day in the Year: the place of the Sun in the Ecliptick: the Azimuth, Right Ascension and Declination of the Sun. With many other necessary and delightful Conclusions. Performed very readily.

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Written by *W. F.*

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Psal. 92. 6. *A brutish man knoweth not: neither doth a fool understand This.*

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The Quadrants and these Books are to be sold by *Joseph Moxon*, at his shop in *Corn-hill* at the Sign of *Atlas*, in *London*. 1655.

P. W.

William Davidson

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530 a. 49
1-2

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BRITISH MUSEUM
45
JLR

# To the Reader.

*READER, What I have here written of the use of the* Quadrant, *was intended for the use of some of my friends, that understand not the use of that Instrument; which when* Mr Moxon *saw, he requested the Copy of me, to accomodate such of his Customers withall, as buy his* Quadrants, *and yet understand not the use of them.*

*What is written concerning this* Quadrant *and* Quadrat, *is written in general for all* Quadrants *and* Quadrats; *but what concerns the* Hour-Lines, *is particular to this Instrument; and were first hinted at by* Stofler, *and afterwards perfected by* M. Gunter; *with addition of* Azimuth Lines, *&c.*

*Now if you desire to learn the projecting of these* Hour *and* Azimuth Lines, *you must peruse* M. Gunter, *who hath made Tables of purpose for the carrying on of these Lines from the* Equator *to the* Tropick, *for this Latitude; and given you directions how you shall make other Tables for all Latitudes: which here is not my task to*

# To the Reader.

*insert. Neither would I have you think th*
*what I have written concerning the use of the*
Hour *and* Azimuth Lines *proceeds from m*
*own head, but from* M. Gunters *instructions*
*which I have digested into such a Method*
*I thought would be most plain for my friends*
*understand. Therefore to them that are unski*
*ful in the use of this Instrument, have I d*
*rected these few lines, and not to the Learne*
*who are better able to instruct me in these a*
*other Mathematical Conclusions, then to r*
*ceive any instructions from*

Their real Well-willer,

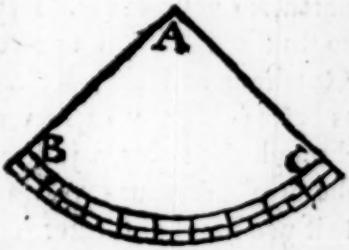
*W. P.*

Compass of ye Earth. 21600. mils.
Thickness of it. 6873. mils.
To ye Center. 3441. mils. 3436. ½

THE

# THE USE Of the Quadrant.

A Quadrant is the fourth part of a Circle, and is comprehended between two Semidiameters; as in the Figure A B C, where A is the Center, A B one of the Semidiameters, and A C the other, and the outmost Verge B C is the Limb of the Quadrant, or more properly the Quadrant it self; being one Quarter of a Circle, and therefore is called by the Latine word *Quadrant*.



The Quadrant B C is divided into 90 equal parts, called Degrees: for, because the whole Circle contains 360 Degrees, therefore the Quadrant which is the fourth part) must contain 90 Degrees: each of these Degrees are divided into half, or quarter, or more, (as the largeness of the Instrument will admit) being numbred at every tenth Degree, as 10. 20. 30. 40. *&c.*

Now forasmuch as 90 Degrees is the highest elevation, or lowest depression of any thing, therefore very aptly doth this Instrument serve for *Mensuration*; as for example:

If you hold the limb of the Quadrant toward you, and the uppermost Semidiameter of the Quadrant parallel with the Earth or Water, then what object soever you behold through the Sights, is just so high above the Earth, as your eye is. If you lift the Center up till the thred fall upon ten Degrees in your Quadrant, and then look through the Sights, as before; then whatsoever object you behold through the sights, is just ten Degrees high, and the height of your eye above the ground: Also if you lift the Center up till the thred fall on twenty Degrees, then what object you see through the Sights, is twenty Degrees high; and so of all the rest.

By

By this you may understand what the Quadrant is made for and what it represents: and though it may be imployed for many other things, as the taking of Angles at any distance, yet the general use is in what is aforesaid. Now therefore I will speak somwhat of the exact way to use the Quadrant, and to avoid error in the use of it.

Take the Quadrant in your hand, and hold it so, that the thred to which the Plummet is fixed, may hang down close by the face or flat of the Quadrant and be sure that the thred do not lean upon the Limb, or that it do not hang too far from it, but that it even touch it; then in this posture bring the Quadrant to your eye and look through both the sights, till you see the Sun, Star, or other object, which you would observe; then holding the Quadrant steddy still looking upon the Sun, Star, or other object lay your finger upon the thred, and so many Degrees as you find between the thred upon the Limb, and the end of the Limb from the Semidiameter upon which the Sights are placed. so many Degrees is the Sun distant from your Zenith; and so many Degrees as is between the thred and the other end of the Limb so many Degrees is the height of the Sun or Star you observe above the Horizon. 2

EXAM-

EXAMPLE.

3 Looking through the Sights to the Sun, I find the thred to fall upon 45 Degrees of the Quadrant; therefore I say, the Sun is just 45 Degrees above the Horizon; and 45 Degrees from the Zenith.

Again, looking through the Sights upon a certain Star, I find the thred to fall upon 39 Degrees and an half; therefore I say, that that Star is 39 Degrees and an half above the Horizon, and 50 Degrees and an half from the Zenith.

*To take the Altitude of the Sun without looking by the eye.*

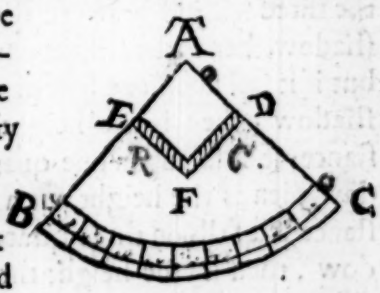
4 LEt the Sun shine through the first sight next the Center, and bring that beam of the Sun to fall right upon the hole of the other Sight, and it will be as well or better then if you had observed it with your eye; and then the thred will fall upon the true Altitude of the Sun above the Horizon.

*What is meant by Altitude?*

5 THe Altitude of the Sun, Moon, or Stars, is not so many Miles, Poles, Rods, &c. as is between the Eye, and the Sun, Moon, or Star; but it is so many Degrees and Minutes as is between the Sun or Star, and the Horizon; and therefore 'tis said to be so far above the Horizon.

on. I take M. *Norwoods* experiment for the
eſt, who ſaith, That a Degree in the Heaven
ontains 69 Engliſh miles or thereabout; ſo
hat this is true, That if I take the Altitude of
he Sun at any time, and finde 53 Degrees
rom my Zenith, I ſay that there is 53 times
9 miles between the place where I am, and
he place in whoſe Zenith the Sun was at that
ime: and by this means you may know how
ar it is to any place over which the Sun or
Star is at any time.

Now in ſome Quadrants there is deſcribed 6
a *Quadrat*, which is made of two lines com-
ming from the Semidiameters, A B and A C,
as in the Figure
you may ſee mark-
ed; and they are
divided into fifty
equal parts. That
part of the Qua-
drat which is next
the Sights, is called
*The Scale of Con-*
*trary ſhadow*; and that other, *The Scale of Right*
*ſhadow*. The uſe of the Quadrat is to take
Heights and Diſtances without meaſuring them.




The beſt and moſt eaſie way for the taking 7
Heights and Diſtances, is by *the Rule of Propor-*
*tion*

sion; becauſe then any ſtation taken will do the work; But becauſe ſome are not ſeen in Arithmetick, I will firſt ſhew how to take Heights and diſtances without the rule of Proportion.

Mark the place whoſe height you would know, and look through the Sights to the place, and go backwards or forwards until the thred fal juſt between the line of Right and Contrary ſhadow upon the Quadrat; which is upon 45 Degrees of the Quadrant; or elſe juſt upon one half of the parts of Right or Contrary ſhadow; or juſt upon one quarter of Right or Contrary ſhadow; then looking through the Sights towards the Center, obſerve til you find the thred fall juſt between Right and Contrary ſhadow; then is the height equal to the diſtance: but if it fall upon one half of the parts of Right ſhadow; then is the height but half the diſtance; if it fall upon one quarter of Right ſhadow, then is the height but a quarter of the diſtance; if it falls on three quarters of Right ſhadow, then is the height three quarters of the diſtance.

N. Now of the parts of Contrary ſhadow; if the thred fall upon half the parts of Contrary ſhadow, then is the height double to the diſtance; if half way between this and the Semidiameter wherein the Sights are placed, then is the height

eight four times as much as the diſtance. Now ccording as the Quadrat is divided you may ind hereby the way to work the queſtion.

I will give you an example of theſe, by which hey may be the better underſtood.

I take a Quadrant that hath a Quadrat the arts of whole right ſhadow are divided into fty parts, and the contrary ſhadow into fifty arts, and I would know the height of a Stee-le: therefore looking through the Sights to the op of it, I finde the thred to fall between Right nd Contrary ſhadow; then I meaſure from the lace where I ſtood, and find it to be 25 yards nd an half between that and the foot of the teeple, to which adding my length from my y to the ground, being a yard and an half, it akes 27 yards, the juſt height of the Steeple: or you muſt alwaies remember to add the ength of your eye from the ground.

Again, looking to the top of the Steeple, he thred falls upon 25 yards of Right ſha-low; and meaſuring, I find 51 yards between ne and the foot of the Steeple; the half where-f is 25 yards and an half, to which adding one ard and an half for my body, makes 27 ards; the height of the Steeple.

Now taking another Station, I find when I ook to the top of the Steeple, that the thred falls

falls upon twelve parts and an half of Right sh
dow; and the distance I find to be 102 yar
one quarter of which is 25 yards and an h
and one yard and an half makes 27 yar
the height of the Steeple.

Now for the parts of Contrary shado
looking to the top of the Steeple, I find 25 pa
of Contrary shadow cut by the thred, and
distance between me and the foot of the St
ple, I find to be 12 yards and an half, whi
being doubled, make 25 yards and an ha
and one yard and an half the length of my b
dy makes 27 yards; the height of the Steep

Again, I look through the Sights to the
of the Steeple, and find twelve parts and a h
of Contrary shadow cut by the thred; and m
suring from my foot to the foot of the Steep
I find it 6 yards and 13 inches; which d
bling four times, it makes it 25 yards and
half; and one yard and an half added to it,
26 yards: the height of the Steeple.

*NB.* Now if standing upon a known height y
would know a distance, work as you did b
fore; onely that which was then the parts
Right, must now be the parts of Contrary sh
dow; and that which was then the parts
contrary shadow, must now be the parts
Right shadow.

I will give you but two examples of this, and let the Reader ſtudy the reſt by this.

Standing upon a Steeple 27 yards high, let the Quadrant be lifted no higher then is the Steeple; if you do, you muſt allow ſo much as it is higher; I look to the root of a Tree, and find the thred to cut 25 parts of that which now is Contrary ſhadow; therefore doubling the height of the Steeple which is 27 yards, you have 54 yards, for the diſtanee between the foot of the Steeple and the root of the Tree.

Secondly, Looking to the bottom of an Houſe-wall, I find the thred fall upon 25 parts of that which is now Right ſhadow; then is the diſtance between the foot of the Steeple and the bottom of that Wall but half the height of the Steeple, which half will come to be 13 yards and an half.

But if looking to a place the thred fall juſt betwen Right and Contrary ſhadow, then is the diſtance and height equal.

In the taking of diſtances upon a height, you muſt do contrary to what you did before; for there you looked firſt through the Sight furtheſt from the Center, but now you muſt look through the Sight next the Center firſt, and then through the next to the place you obſerve: and

note

note. that by Heights we speak onely of perpendicular or upright Heights, and in Distance onely of Levels.

*N.* Now follows the use of the Quadrat by Arithmetical Operations.

*I.* First for the taking of heights: Take any station and look to the top of the Wall House, Window, Steeple, or Tree, whose height you would know; but get your station as near it as may be, then mark whether the thred fall upon the parts of Right or Contrary shadow; if it fall upon Right shadow, then as all the parts of Right shadow are to the parts between the thred and the Semidiameter, so is the distance to the height.

But if the thred fall upon the parts of Contrary shadow, then as the parts between the thred and the Semidiamiter are to all the parts of Contrary shadow, so is the distance to the height; and of the contrary of these two it holds good, that is, That as in Right shadow as the whole of the parts is to the parts cut by the thred, so the distance is to the height: So on the contrary; As the parts between the thred and the Semidiameter are to all the parts of Right shadow, so is the height to the distance, and in the parts of Contrary shadow it holds true:

That

That as all the parts of Contrary ſhadow are to the parts between the thred and the *Radius*, ſo is the height to the diſtance. So that obſerving this for a general rule, it is eaſie to find any height or diſtance. I will give two or three examples in both theſe caſes, and firſt of Right ſhadow.

Take a Quadrant whoſe Quadrat hath each divided into 50 parts, and looking to the top of a Steeple, I find the thred to fall upon 7 parts of Right ſhadow, and I meaſure to the foot of the Steeple, and I finde it to be 520 yards; then I ſay,

As 50 the whole of the parts of Right ſhadow is to 7, the parts between the thred and Semidiamiter, ſo is 520 the diſtance given, to 72 yards, 3 foot, 4 inches, the height required.

EXAMPLE II.

I look to the top of a Tree through the Sights and find the thred fals upon 44 parts of Right ſhadow, and from my foot to the foot of the Tree five yards; then I ſay,

As 50 the whole parts of the ſhadow is 44, the parts cut by the thred; ſo is 5 yards the diſtance meaſured to 4 yards, 1 foot, and 2 inches the height required.

Now for the taking of a distance, being upon a known height.

EXAMPLE.

Standing in a Window so that between my Eye and the Ground were nine yards, and looking to the foot of a Tree or House, I find the thred to fall upon 25 parts of Right shadow, then for the distance between the foot of the Tree and the foot of the House, I say,

As 25 the parts whereon the thred falls is to 50, all the parts of Right shadow; so is 9 yards the height given to 18 yards, the distance required: And always when you stand upon a height to take a distance, you must look through that Sight next the Center first.

Secondly for the parts of Contrary shadow.

Looking to the top of a House, I find the thred to fall upon 17 parts of Contrary shadow, and the distance betwen me and the House I find to be 6 yards: then I say by proportion;

As 17, the parts on which the thred falls, is to 50, all the parts of the shadow; so is 6 yards the distance to 17 yards 2 foot, the height sought.

EXAMPLE.

Standing upon a Tower 50 yards high, I see a Hills foot through the sights, and the thred

thred falls upon 27 yards of Contrary ſhadow: therefore I ſay,

As 50 the whole content of the parts is to 27, the parts cut by the thred; ſo is 50 yards, the height, to 27 yards the diſtance of the place I ſaw. And ſo you may do in any caſe, obſerving well the general rule laid down before.

It reſteth that I ſpeak a little of knowing how to find a Height or a Diſtance, at two ſtations, meaſuring only the diſtance between them: for ſometimes you cannot meaſure the diſtance to the Wall by reaſon of ſome hindrance.

For the ſolution of this, do thus: Work as is beforeſaid: onely whereas then you had either the height or diſtance given, now you muſt give a gueſs at the height or diſtance; and having ſuppoſed the diſtance to be ſo much, I have before ſhewed how to find the height: and alſo having the height ſuppoſed, to find the diſtance. This is laid down before, either when the thred falls upon the parts of Right or Contrary ſhadow.

Then having taken the height or diſtance by ſuppoſition, take another ſtanding, and make your ſecond obſervation; and taking the firſt ſuppoſed height for granted, find out your di-

ſtance as is taught before; having ſo done, you have theſe four things given, *viz* :

1. The ſuppoſed height.

2. The ſuppoſed diſtance from the firſt ſtation to the thing you obſerve.

3. The diſtance from the ſecond ſtation and by that

4. The diſtance of the two ſtations one from another. All this is but ſuppoſed. Now meaſuring between the firſt and ſecond ſtations I find my errour ; therefore all the errours being proportional, I ſay thus :

As the ſuppoſed diſtance between the two ſtations is to the true diſtance between them, ſo is the ſuppoſed height to the true height : and as the ſuppoſed diſtance is to the true diſtance of the ſtations, ſo is the ſuppoſed diſtance of either ſtation from the thing obſerved, to the true diſtance of either ſtation.

Thus you may take the height of a Mountain, or of a Houſe, Tree, or any thing, and the true diſtance between you and the place juſt under the height you obſerve.

Now will I give examples of this, and ſo conclude with the Quadrat.

I would know the height of a Steeple, therefore taking one ſtation, I find the thred fall on 35 parts of Right ſhadow ; and becauſe I can-

not

not measure to the Steeple, because of the unevenness of the ground, or some other impediment, therefore I suppose the distance 40 yards: Then I say,

As 50 the whole parts of the shadow to 35 parts cut by the thred, so is 40 yards the supposed distance to 28 yards, the supposed height.

Then going a little further in a straight Line, so that my first station lie between my second station and the steeple, I find the thred to fall upon 33 parts of right shadow: Then I say,

As 33 parts cut by the thred is to 50 the whole parts of the shadow; so is 28 the supposed height to 42 yards, 1 foot, 3 inches, the supposed distance of the second station: so that the second station is distant from the first station by supposition 2 yards, 1 foot, 3 inches. Now if measuring these distances, I find it to be but 2 yards 3 inches; Then I say,

As 2 yards, 1 foot, 3 inches the supposed distance of the 2 station is to 2 yards 3 inches, their true distance,

So is 28 yards, the supposed height to 24 yards, 4 inches the true height.

Then for the distance, I say,

As 28 yards the supposed height to 24 yards 4 inches the true height; so is 42 yards, 1 foot, 5 inches the distance of the second

ſtation to 36 yards, 1 foot, 7 inches the true diſtance of the ſecond ſtation.

Then for the diſtance of the firſt ſtation; Take away their difference 2 yards, 1 foot, 3 inches, and the remainder will be the diſtance of the firſt ſtation.

Thus ye may do when it falls upon the parts of Right ſhadow, but if the thred fall upon the parts of Contrary ſhadow, then do as by this example following:

Looking through the Sights to the top of an hill, I find the thred to fall upon 20 parts of Contrary ſhadow; then ſuppoſe the height to be 84 yards, I ſay,

As 50 to all the parts of the ſhadow is to 20, the parts cut by the thred; ſo is 84 yards the ſuppoſed height to 33 yards two foot, the ſuppoſed diſtance of the firſt ſtation.

Then going further off, I make obſervation, and find the thred to fall upon 22 yards of contrary ſhadow: Then for the diſtance I ſay,

As 50 the parts of Contrary ſhadow are to 22 parts, cut by the thred, ſo is 84 yards the ſuppoſed height to 34 yards, 2 foot, 10 inches, the ſuppoſed diſtance of the ſecond ſtation: ſo that the difference by ſuppoſition between the two ſtations, is 1 yard and 10 inches.

Now

Now if I meaſure the diſtance of the two ſtations, I find them to be diſtant three yards, I ſay firſt for finding the true height;

As 1 yard 10 inches, the ſuppoſed difference of the two ſtations, is to 3 yards their true difference; ſo is 84 yards the ſuppoſed height to 197 yards 7 inches the true height.

Therefore the diſtance I ſay,

As 1 yard 10 inches the ſuppoſed diſtance of the ſtations to 3 yards their true diſtance; ſo is 3 yards, the ſuppoſed diſtance of the firſt ſtation to 77 yards, 1 foot, 5 inches, the true diſtance of the ſame firſt ſtation: To which if you adde 3 yards, you have 80 yards, 1 foot, 5 inches, the diſtance of the laſt ſtation.

And in the working of this, let the Reader be very exact. Firſt in his Obſervations. Secondly, in his Calculations; and then he need not doubt but his work will come true and right.

This might have been exceedingly illuſtrated, if prolixity had been affected; but I doubt not but by this a carefull Student will accompliſh any queſtion either of the Heights or Diſtances of things; or in taking the Altitudes of the Sun, Moon, or Stars: And in thy reading, if any thing ſeem dubious unto thee,

look forward or backward, and then thou wilt by comparing one thing with another, find out the real truth.

## SECT. II.

*Shewing the use of Houre lines, and Azimuth lines, &c.*

BEcause the Quadrat and Quadrant fills not up the Instrument, but that there is vacant places left without any inscription; therefore many knowing men have invented several Lines &c. to fill them up with:

And first of all, *Stophler* (in his *Elucidatio Fabricæ ususque Astrolabii*) teaches to make Hour-lines for the time of the day; yet he describes them in his Quadrant in such an imperfect manner, that it is plainly to be seen he rather affected ease, then truth.

Since him, M. *Gunter* hath invented Hour-lines, after a more perfect way, and also illustrated the Quadrant with Azimuth-lines, and a Scale of the days of the Moneth, an Arch of

the

the Horizon, and the Ecliptique line, and alſo the Places of ſome notable Stars that lie between the Equator and Tropick.

Others have alſo have exerciſed their wits in inventing ſeveral Conceits to fill the Inſtrument up with; as namely M. *De le Main*, M. *Outred*, M. *Foſter* M. *Stirup*, M. *Darry*, *&c.* All differing one from the other, as I ſhall hereafter ſhew in convenient place.

But firſt I ſhall ſhew you the uſe of divers Lines that M. *Gunter* hath deſcribed in his Quadrant: and though they be ſufficiently and learnedly handled by himſelf in his Book; yet I think it not amiſs to make them plain and eaſie to be underſtood of ſuch as are not otherwiſe Mathematically given; but onely deſire to know the uſe of the Quadrant, &c.

And therefore I ſhall begin with the Circle of Moneths, which you ſhall find deſcribed juſt within the Limb, in 4 Arches of Circles; one end of them reaching to 62 Degrees of the Quadrant, and the other to 25 Degrees of the Quadrant.

The two next the Quadrant or Limb, are from the tenth of *June*, till the eleventh of *December*; all which time the days ſhorten to us who live under the North Hemiſphere; and in the ſame time the Sun goeth from the begin-

ning

ning of ♋ to the beginning of ♑. The other two Circles do contain the other half of the year; that is, from the eleventh of *December* to the tenth of *June*: each Moneth at the beginning of it is noted with the first letter of that Moneth; as J F M A M J J A S O N D: That is, *January*, *February*, *March*, *&c.*

Each of these Moneths is divided into every fifth day, or every particular day, as the largeness of the Instrument will bear it, by a small stroke drawn cross the two Circles; and those strokes that extend themselves on the one side to the Limb, and on the other side to the Circle next above them, note the beginings of a Moneth; and at that stroke is set the letter that notes the Moneth that begins.

Secondly, Next to this Circle of Moneths towards the Center, where the thred is fastned is a Circle (or rather an Arch of a Circle drawn from one Semidiameter to the other; and this is called the Tropick, and serveth in its use for both the Tropick of ♋ or ♑, at one end you may find this Arithmetical Figure 8 and at the other end these two Characters ♋ and ♑.

Thirdly, That Circle which you see part of it covered by the Quadrat, and hath these Figures upon it, 6. 7. 8. 9. 10. 11. 12. 30

60

0. 90. is the Equator or Equinoctial : It drawn from one Semediamiter to the other, nd is neareſt the Center of any other of the Circles.

Fourthly, That Circle which is drawn from he Fgure 6 in the Equator to the end of the Tropick, and is divided by ſmall pricks thus, ..... &c, is the Ecliptick; and upon it are ut the Characters of the twelve Signs of the Zodiack thus ♈, ♎, ♑, ♋, ♉, ♍, ♌, ♒, ♊, ♐, ♓, ♑; but you muſt read them in due order, s ſhall be ſhewed hereafter.

Fifthly, From 6 in the Equator to the latter end of *February* in the Circle of Moneths, s drawn a Circle (or Circular-line, for ſo you muſt take it,) and is divided with ſmall pricks s the Ecliptick is, and is numbred from the Equator to the Tropick : This Circle is called he Horizon.

Sixtly, From the Equator to the Tropick pon the Semidiameter, is a diviſion of 23 equal parts, and one half of a part numbred 10 nd 20 : This is called the Line of Declination.

Seventhly, From 7. 8. 9. 10. 11. 12. in the Equator, are drawn ſix Lines, bending towards he Line of Declination ; and again, from 22 and 12 parts in the Line of Declination; and ſo from

from 6.7.8.9.10.11.12. in the Equator, and bending from the Line of Declination, and are nine in number: These crossing the other that bend towards the Line of Declination, are all of them called the Hour-lines. And here note, That that Hour-line which is drawn from 12 in the Equator, to the Tropick just over *Juno* in the Circle of Moneths, is the bounds of the Circle of Hours.

Eighthly, All those Circles drawn on the other side, of which I have said nothing yet, are the Azimuths, and are numbred with 30,60, 90 in the Equator; and with 100,110, 120 upon the Semidiameter: the number of them drawn bending towards the Line of Declination, is 13; and those drawn the other way bending, are nine in number.

Lastly ye may see *Peg. wing*, or *Pegasus wing*, and *Arctus*, or *Arcturus*: and *Cor* ♌, or the *Lions heart*: and the *Bulls eye*: and the *Vulters heart*: Each having placed by them a small Star thus, * which are the names of five Stars, which are all between the Equator in the Heavens; and the Tropick of ♋: in some Quadrants is set down the time of their coming to the South at one time in the year; so that if ye look back, ye have these parts following.

1. First

1. First the Limb divided into 90 Degrees.
2. Secondly the two Semidiameters.
3. Thirdly the Quadrat with Right and Contrary shadow.
4. Fourthly the Circle of Moneths.
5. Fifthly the Tropick.
6. Sixthly the Equator.
7. Seventhly the Ecliptick.
8. Eightly the Horizon.
9. Ninthly the Line of Declination.
10. Tenthly the Hour-lines
11. Eleventhly the Azimuths.
12. Twelfthly the 5 Stars.

Lastly the Center where the thred is fastned. Besides this it must have a Plummet, and a Bead, upon the thred, and two *Sights.

* *The Sights are two pieces of Brass, with two little holes in them, to look thorow, or to let the Sun shine thorow; & these Sights are placed upon one of the Semidiameters.*

*The use of the Circle of Months, Ecliptick, Horison, Line of Declination, Hour-Lines, Azimuths, and the five Stars, are briefly as followeth.*

First the Use of the Circle of Months.

TO find any day of the year required, first look out the Moneth; and then

then from the beginning of it count at the firſt croſs ſtroke five days (unleſs the Moneths be divided into particular days,) and the next ſtroke five more, that is ten days; till you come at the day you look for.

EXAMPLE.

I would find the ſeventeenth day of *November*; then having found N for November, I count towards *December*, that is towards D; and ſay, 5, 10, 15, 20: therefore between 15 and 20 muſt be 17. So I gueſs at the ſeventeenth day, and lay the thred upon it, and find it to fall upon 17 Degrees and an half in the Limb. Now in *June* or *December*, 'tis hard to find the day of the Moneth, or to ſeven or eight days; but all the reſt of the year it is eaſie enough.

2. Having found the day of the Moneth, to find how high the Sun will be at Noon:

Lay the thred upon the day of the Moneth and the Degrees cut by the thred in the Limb is the Meridian Altitude, or the height of the Sun at Noon; ſo the height of the Sun upon the eighteenth day of *May*, you will find to be 41 Degrees 45 Minutes.

3. Thirdly, to find what days of the year are of equal length.

Lay the thred upon the day given, and o

th

e other ſide it will fall upon the day equal in ngth to that.

pag. 5. 69. mils for a de.

EXAMPLE.

I deſire to know what day is juſt as long r as ſhort) as the eighteenth of *May*; I lay e thred to the eighteenth of *May*, and on e other ſide it falls upon the fifth day of *Sep-mber*; ſo that theſe two days are both of a ngth, and the height of the Sun at Noon up- either of them is 41 Deg. 45 Minutes.

Note that the height of the Sun at oon here given is true onely at the renowned ity of *London*, or at any place that lieth due ſt or Weſt from it; but in any place that is o Miles more North then Eaſt or Weſt of *ndon* to them, the Sun will be a degree low- then by the Quadrant (fitted for *London*) ill appear; but if you be 70 Miles South of *ondon*, then will the Sun be a Degree higher en the Quadrant will ſhew; and ſo allowing o Miles for a Degree, you may make this uadrant univerſal in this thing.

4. If you have the height of the Sun at oon, you may find the day of the Moneth; ut this is difficult to do it truly.

Secondly, *The Uſe of the Ecliptick Line.*

THis Line as is before-ſaid, is drawn fro ſix in the Equator, to the other ſide of t Tropick, and is divided by ſmall pricks ſhe ing each ſingle Degree; and at the beginning each ſign is a long ſtroke; and at every ten Degree a ſtroke a little ſhorter, and ea fifth Degree with a ſhorter ſtroke. Now up this Arch are the Characters of the twel ſigns, which you muſt note follow one an ther in this order, ♈ ♉ ♊ ♋ ♌ ♍ ♎ ♏ ♐ ♑ ♒ ♓: and theſe twelve ſigns anſwer to t twelve Moneths of the year, and do proce on in order.

And here is to be noted, That the Sun e ters ♈ upon the tenth of *March*, and ♉ t tenth of *April*, and ſo of the reſt; ſo that *February* the Sun will be found to be in Now I ſhall ſhew you how to ſet your Be for any day, which muſt be done thus:

From twelve in the Equator, to the end the Circle of Months, is drawn an Hour-line and from the ſame twelve in the Equator, t the other end of the Circle of Moneths, drawn another Hour-line.

That which falls upon *December*, is th Hour-line of twelve in the Winter; and the

the

ther the Hour-line of twelve a clock in the Summer: Now lay the thred upon the day of the Moneth, and move the Bead up or down, till it lie juſt upon one of theſe two Lines, and ſo is your Bead rectified for that day. So upon the 18 of *March*, bring the thred to the day of the Moneth, and move the Bead up or down, till it falls upon the Hour-line of twelve in the Summer.

How to find theſe three things following upon the 18 of *March*.

Firſt to find the Suns place in the Ecliptick.

Having rectified the Bead as before, bring it to the Ecliptick, and it will fall upon the Degree the Sun is in that day: ſo upon the 18 of *March*, I find the Sun to be in 8 Degrees of ♈; and upon the 17 of *October*, I find it to be in 3 Degrees of ♏, ♏ being the Sign anſwering to *October*; and ſo by the contrary. Iif you know the place of the Sun, you may find the day of the Moneth.

Secondly to find the Suns Declination.

Having rectified the Bead as before, bring it to the Line of Declination, and it will ſhew you the Declination of the Sun for that day: Thus upon the 17 of *October* I find the Sun to have 12 Degrees Declination; and upon the 18 of *March*, it hath three Degrees and an

half Declination: And note, that if the Bead fall upon the Winter twelve a clock Line, then is the Declination South; but if the Bead fall upon the Summer-Line of twelve a clock, then the Declination is North: and by the ſame way if you have the Suns Declination given, you may find his place in the Ecliptick, and the day of the Moneth.

Thirdly to find the Right Aſcention of the Sun.

Having rectified the Bead, bring it to the Ecliptick, and the Degrees cut by the thred in the Limb, is the Right Aſcenſion: But when the Sun hath gone three Sines from ♈, for every three Signs you muſt add 90 Degrees to the Right Aſcenation cut in the Limb; and then have you the Right Aſcenſion. Thus upon the 18 of *March* the Right Aſcenſion is 12 Degrees; and upon the fifth of *Auguſt* 126 Degrees; and upon the 10 of *October* it is 208 Degrees; and upon the 9 of *March* it is 360 Degrees.

Thirdly, *The uſe of the Horiſon Line.*

THis line is divided by ſmall pricks, and divided into 40 parts; and is numbred 10, 20, 30, 40. The uſes of it are three, *viz.*

Firſt to find the Suns Amplitude, or his Riſing or Setting from the true Eaſt or Weſt points

points of the Compaſs in the Horizon of *London.*

Having rectified the Bead, bring it to the Horizon, and it will ſhew the Amplitude. Thus upon the 9 day of *April* the Amplitude is 19 Degrees toward the North: And note, that from the 10 of *March*, to the 11 of *September*, it hath North Amplitude; but all the reſt of the year, the Amplitude is South.

Secondly to find the Aſcenſional difference.

Rectifie the Bead, and bring it to the Horizon, and the Degrees cut in the Limb ſhall be the Aſcenſional difference: Thus the Aſcenſional difference the 9 of *April* is 15 Degrees; and having the Aſcenſional difference, 'tis eaſie to find the time of Sun-riſing and Setting; and thereby the length of the day and night.

Firſt for the time of Sun-riſing.

Find out the Aſcentional-difference, then if the time be between the tenth of *March*, and 11 of *September*, allow for each Degree of Aſcenſional-difference 4 Minutes of time, and ſo much doth the Sun riſe before 6 in the Summer, and after 6 in the Winter.

So upon the 9 of *April* I have 15 Degrees of Aſcenſional difference, which is 15 times 4 Minutes, that is juſt an hour: Now becauſe 'tis in the Summer, I ſay the Sun riſeth

an hour before 6 in the morning, that is, at 5 a clock in the morning. And note that ſo much as the Sun riſes before 6, ſo much it ſets after 6; and ſo much as it riſes after 6, ſo much it ſets before 6.

To find the length of the day is eaſie; for counting the time from Sun-riſing till Noon the ſame day, I have 7 houres; and the Afternoon being alwaies the ſame length as the Forenoon is of, gives me 7 more; which added together, makes 14 hours for the length of the day; which taken from 24 hours, leaves 10 hours the length of the night. Thus ye may find the time of Sun-riſing and Setting, and the length of the day and night, to a Minute of time.

Fourthly, *The uſe of the Hour-lines.*

THoſe Lines that are drawn from 6 7 8 9 10 11 12 in the Equator, bending towards the Line of Declination, are the hours of the day in the winter, and of the night in the ſummer; and they are numbred firſt In the Equator, to ſhew what hour they do belong to: And again they are numbred above the Tropick. The other Hour-lines drawn bending from the Equator, are the hours of the day in the Summer, and of the night in the Winter: the

they are numbred in the Equator, and in the Tropick; ſo that the firſt drawn from 12 in the Equator to the end of *June*, is 12 a clock at Noon in Summer, and 12 at Night in Winter; the next is 11 or 1 a clock before Noon in Summer, and 11 and 1 a clock at night in Winter; and ſo you may find out all the reſt, as by the enſuing particulars will more plainly appear.

Now in a large printed Quadrant lately engraved by M. *Moxon*, and by him very accurately paſted on a board, and fitted up with Sights, Plumb-line and Beads; you have betwixt the Hour-lines other ſubdiviſions drawn from the Equinoctial to the Tropick with touches of Lines thus - - - - - - - - - which ſhew the half hours; and betwixt each half and whole Hour-line, you have another Line of Pricks thus..... and ſerve to diſtinguiſh the quarter hours. This being premiſed, we now come to the uſe of them.

Firſt, Having the height of the Sun, to find the hour of the day.

Firſt rectifie your Bead, then take the Altitude, and the Bead will fall upon the hour of the day; As for example:

I rectifie the Bead upon the 9 of *April*, and taking the height of the Sun, I find it 31 Degrees

grees high, and the Bead at that obſervation fell juſt half way between the Lines of eight and nine in the Equator, and three and four at the Tropick; ſo that it is half an hour paſt 8 in the Morning, or half an hour paſt three in the Afternoon: now if the Sun riſes higher it is before Noon; but if it deſcend lower and lower, then 'tis Afternoon.

And ſo by the ſame way upon the firſt of *November* I make obſervation, and the Bead falls half way between 1, and 9, and 3, and 4, in the winter Circles; therefore 'tis half an hour paſt 3 in the Afternoon, or half an hour paſt 8 before Noon: and thus with a little diligence you may find the hour of the day to a ſmall matter.

Secondly to know how high the Sun will be at any hour:

Rectifie the Bead, then bring it to the time given, and the thred will cut ſo many Degrees in the Limb, as the Sun will be high at that time: thus upon the 30 of *March* I find that at 8 a clock in the Morning the Sun is 24 Degrees and an half high, and it comes to the ſame height at four in the Afternoon the ſame day.

Thirdly to find how low beneath the Horizon the Sun is at any hour of the Night.

Recti-

Rectifie the Bead for the preceding day, and bring it to the hour of the night, and in the Limb the thred will ſhew you how low the Sun is at any time of the Night: thus upon the 30 of *March* at 11 at Night the Sun is 28 ½ Degrees low, beneath our Horizon.

Fourthly to find the time of Day-break:

This is when the Sun is 18 Degrees beneath our Horizon; Therefore rectifie the Bead for the day, and lay the thred upon 18 Degrees in the Limb, and the Bead will fall upon the hour of Day-break; ſo upon the 30 of *March* the day will break at three of the clock in the Morning. And by this is eaſie to find when it will be dark at night, for that muſt be ſo much after 6, as this is before 6, which is 3 hours; ſo at 9 at night it will be dark, or paſt Twilight.

As on the left hand of the Quadrant, the Hour-lines are drawn bending from the Equinoctial to the Tropick; ſo likewiſe on the right hand of the Quadrant are drawn ſuch other Lines, which bend alſo from the Equinoctial to the Tropick, and are called *Azimuths*; and are numbred in the Equinoctial with 10 20 30 &c. to 90, and then downwards from the Equinoctial to the Tropick with 130 110 120, and ſome odd degrees of

Azi-

Azimuth. Now on the Quadrant I mentioned before, you have not onely every tenth Azimuth-line described, but also every fifth Azimuth-line drawn with such touches of Lines, as the half hours are marked with.

Fifthly, *The use of the Azimuth lines.*

*Note.* THat those Lines that bend towards the Line of Declination, are the Summer Azimuths; and that which is neareſt the Line of Declination, which is on the left hand, is the Meridian Line, or full South in Summer.

And all those drawn the other way, are the VVinter Azimuths; and that next the Line of Declination (though bending from it towards the right hand) representeth the Meridian, or full South point of the Compass in the VVinter.

But to find the point of the Compass wherein the Sun bears at any height, do thus:

First rectifie your Bead:

Then take the Altitude of the Sun, then observe well that Altitude, and so much as your Altitude is, count so many Degrees in the Limb from 90, & bring the thred to that Degree; then will the Bead fall upon the true Azimuth.

EXAM-

EXAMPLE.

Upon the 9 of *April* I take the height of he Sun, and find it to be 25 Degrees; therefore lay the thred 25 Degrees from 90 Degrees, nd the Bead falls upon almoſt 80 Degrees rom the Meridian; whether this 80 Degrees e from the Meridian to the Eaſtward, or to he Weſtward, I know by the time of the day; or if it be after Noon, then it is 80 Degrees o the Weſtward; but if before Noon, 80 Degrees to the Eaſtward: this is of many great ſes, and therefore I will ſhew how to draw Compaſs upon any place whereon the Sun hines be it either upon a Wall, or on the Ground.

Firſt with a pair of Compaſſes deſcribe a ood large Circle, the bigger the better; then when the Sun ſhines upon the Circle, ſet up ſmall ſtick or nail upright in the middle or Center of the Circle; then take the height of he Sun, and note it well; then preſently make mark at the end of the ſhadow of the nail or ſtick; then take away the nail, and lay a Ruler over the Center, and the mark you made t the end of the ſhadow, and ſo draw a Line rom one ſide of the Circle to the other, by the de of the Ruler, then (as is before ſhewed) ou may find how much one end of that Line

is

is from the true South: then having so ma
Degrees as the Sun was from the South, l
the Center of the Quadrant upon the Cent
of the Circle; and from the Center of t
Quadrant extend the thred to the place
the Sun upon that Circle, and bring that D
gree which you know the Sun is from t
Meridian under the thred, and one end
the Limb will point at the true South, t
other at the East, if it be before Noon, b
to the West, if it be after Noon; then is t
North opposite to the South, and so have y
the true East and West, North and South
any place whatever, which is any thing ne
*London*; as within 100 miles the errour wil
but small, but if it be true East or West fro
*London*, the errour will be scarce any thin
And thus you may find several particulars;
in finding how one place lyeth from anothe
and also to describe a Dial on a plain lev
place: and how much the Magnetick Need
varies in any place.

Now you may divide the Circle you mak
into 360 Degrees, and describe the 32 poin
of the Compass, and many very rare conclus
ons. And as I desire thee to take heed of a
errours and mistakes, so especially in this th
you be sure to account your Altitude from 9
to

wards 10 Degrees in the Limb; for this you uſt alwaies do in finding out the Suns Azi-uth, or point of the Compaſs: and ſo by the ontrary 'tis eaſie to find the height of the Sun any Azimuth thus:

1. Rectifie the Bead, then bring it to the zimuth whereon the Sun is, and ſo many egrees in the Limb, as is between the thred nd 90 Degrees, or the end of the Limb; ſo uch is the Altitude at that time.

Laſtly, *The uſe of the five Stars is thus:*

IN ſhort, becauſe 'tis difficult, and the Nocturnal being better for this purpoſe:

1. Put the Bead to the Star you intend o obſerve, and find how many hours it is iſtant from the Meridian, or 12 at night, as ou found how far the Sun was diſtant from 2 at Noon; then find the Right Aſcenſion f the Sun, and alſo the Right Aſcenſion of at Star; then out of the one, take the other, nd turn the reſt into time; allowing 15 egrees for an hour, and 4 Minutes for Degree; then that time you found to re-ain after the ſubſtraction, add to the hours ou find the Star from the Meridian, and they

they will make the time that is since twe
a clock at Noon.

The right Ascension of the five stars are
followeth, *viz:*

| Magnitude, | | Right Ascensi |
|---|---|---|
| 2 | *Pegasus Wing,* | 342 |
| 1 | *Arcturus,* | 210 |
| 1 | *Lyons Heart,* | 147 |
| 1 | *Bulls Eye,* | 64 |
| 2 | *Vultures Heart.* | 293 |

| | Declinatio | |
|---|---|---|
| *Pegasus Wing,* | 13 | 24 |
| *Arcturus,* | 21 | 01 |
| *Lyons Heart,* | 15 | 36 |
| *Bulls Eye.* | 15 | 47 |
| *Vultures Heart.* | 8 | 02 |

*FINIS.*